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PRODUCTION OF LENS SHEET

[*Renzu shiito no seizoh houhoh*]

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[There are no amendments to this patent.]

Specification

1. Title of the invention

Production of lens sheet

2. Claim of the invention

In the production of a lens sheet consisting of coating a first ionizing radiation curing resin over the entire surface of a molding tool having a lens pattern, forming a resin pool of a second ionizing radiation curing resin onto the above-mentioned first ionizing radiation curing resin coated over the above-mentioned molding tool, superimposing a base material uniformly over the resin pool of the above-mentioned second ionizing radiation curing resin and laminating the second ionizing radiation curing resin onto the above-mentioned first ionizing radiation curing resin with a pressure roll, irradiating the above-mentioned ionizing radiation curing resins with ionizing radiation to cure them, and releasing the above-mentioned cured ionizing radiation curing resin molding from the above-mentioned molding tool, a lens sheet characterized by the fact that the above-mentioned first ionizing radiation curing resin is coated in a direction that is at a right angle to the direction of application of the second ionizing radiation curing resin.

3. Detailed description of the invention

[Technical field of the invention]

The present invention pertains to the production of a lens sheet wherein the lens members of the lens sheet are made of an ionizing radiation curing resin is used for transmission type screen such as a fresnel lens sheet, prism lens sheet, or lenticular lens sheet, and the invention further pertains to a method of producing a lens sheet that includes an improved resin coating process with an absence of migration of air bubbles in the lens member.

[Prior art]

Historically, the above-mentioned lens sheet has been produced by methods such as press molding and casting. In the press molding method, a heat treatment, pressurization, cooling cycle are used and productivity is low. In the casting method, a monomer is poured into a mold and polymerization is carried out; thus, production time is long; furthermore, many molds are required; thus, the production cost is high.

[p. 2]

In order to solve the above-mentioned problems, a method wherein an ionizing radiation curing resin such as a ultraviolet curing resin or electron beam curing resin is poured into the space between a molding tool and a base, and an ionizing radiation such as ultraviolet or electron beam is applied, and curing of the above-mentioned resin is achieved (photopolymerization method) is proposed.

For example, in "Production of a Screen for Video Projectors" disclosed in Japanese Kokai [Unexamined] Patent Application No. Sho 62-33613 [1987] "a method wherein a ultraviolet curing resin is injected into a lens die under ambient pressure and covered with a

ultraviolet-transmitting sheet, and ultraviolet is applied to the ultraviolet curing resin filled between the ultraviolet-transmitting sheet and die through the above-mentioned ultraviolet-transmitting sheet and releasing of the cured ultraviolet curing resin" is proposed.

[Problems to be solved by the invention]

However, the method proposed above has the problems described below associated with it.

First, as a means used for lamination of the ultraviolet-transmitting resin on the ultraviolet curing resin injected into the die, "a method whereby the ultraviolet-transmitting base material is brought into contact with one side of the die injected with the ultraviolet curing resin using a vacuum device, the corresponding other side is covered by the ultraviolet curing resin so that covering is done without trapping air bubbles" is proposed. However, in order to achieve the above-mentioned objective with a vacuum device, control of the device and driving of the device is complicated, and the production cost is increased; furthermore, covering without trapping air bubbles at all is impossible.

Secondly, in the case of migration of air bubbles in the resin at the time of injection, "removal with a pipet, etc.", is proposed, but migration of air bubbles takes place at random and when it is necessary to detect migration of air bubbles and to remove air bubbles manually, productivity is reduced and removal of the air bubbles is uncertain.

Thirdly, defoaming of the resin is required before injection; thus, equipment and time are required, as a result, productivity is low and production cost is increased.

When the above-mentioned air bubbles are allowed to remain in the lens member, the quality of the lens is reduced and image quality is reduced.

The purpose of the present invention is to eliminate the above-mentioned existing problems and to provide a production method for a lens sheet with an absence of air bubbles without an increased production cost.

[Means to solve the problem]

As a result of much research carried out by the present inventor, it was found the above purpose can be achieved when the coating method wherein an ionizing radiation curing resin is used is improved and the present invention was accomplished.

Fig. 1 is a schematic drawing used for explanation of the lens sheet production process of the present invention.

The lens sheet production process of the present invention is a manufacturing process consisting of coating a first ionizing radiation curing resin over the entire surface of a molding tool having a lens pattern (first resin coating process 101), forming a resin pool of a second ionizing radiation curing resin on the above-mentioned first ionizing radiation curing resin that has been coated over the above-mentioned molding tool (second resin application process 102), superimposing the base material uniformly over the resin pool of the above-mentioned second ionizing radiation curing resin and laminating the second ionizing radiation curing resin onto the above-mentioned first ionizing radiation curing resin with a pressure roll (uniform lamination process 103), irradiating the above-mentioned ionizing radiation curing resins with an ionizing radiation to cure them (resin curing process 104), and releasing the above-mentioned each ionizing radiation cured resins from the above-mentioned molding tool (release process 105), wherein, the above-mentioned first ionizing radiation curing resin is coated in a direction that is at a right angle (first resin coating process 101) to the direction of application of the above-

mentioned second ionizing radiation curing resin (uniform lamination process 103).

The first resin coating process step 101 is a process step wherein the first ionizing radiation curing resin is coated over the entire surface of a molding tool having a lens pattern. The above-mentioned process is a process wherein wetting of the molding tool is done uniformly, and at the same time, the coating ratio is stabilized, and defoaming is promoted in the process step that follows. In specific terms, the above-mentioned process step can be achieved by means of the roll coating method, silk screen coating method, curtain coating method, gravure coating method, squeegee coating method, etc.

The second resin application process 102 is a process where the resin pool of the second ionizing radiation curing resin is formed at the end of the above-mentioned molding tool. The function of the second ionizing radiation curing resin used in the above-mentioned process is to purge air bubbles trapped between the base material to be laminated and the molding tool, and at the same time, and to impart adhesion with the base material.

[p. 3]

As for the method used for formation of the resin pool of the second ionizing radiation curing resin, methods such as squeegee coating, flow coating, roll coating, and quantitative separation method can be used.

Lamination process step 103 is the process step wherein an ionizing radiation-transmitting base material is superimposed on the above-mentioned resin pool of the second ionizing radiation curing resin and lamination is performed for the above-mentioned base material onto the above-mentioned second ionizing radiation curing resin as the second ionizing

radiation curing resin is being evenly pressed by a pressure roll. In the above-mentioned process, air bubbles migrating into the space between the molding tool and base component are purged and the thickness of the molded article is made uniform.

Resin curing process step 104 is the process step wherein an ionizing radiation is applied to the above-mentioned ionizing radiation curing resins and curing is achieved. In the above-mentioned process, curing of the second ionizing radiation curing resin is performed upon application of ionizing radiation such as ultraviolet or electron beam, and in this case, it is desirable when the light source is brought as close as possible to the roll area pressed by the roll. In this case, lifting between the molding tool and base component and migration of air bubbles into the above-mentioned space can be prevented.

Release process 105 is the process step wherein the above-mentioned ionizing radiation cured resin molding is released from the molding tool.

For the above-mentioned ionizing radiation curing resins, ultraviolet curing resins or electron beam curing resins can be used, and for example, one or a mixture selected from the group consisting of polymeric oligomers and monomers having an acryloyl group such as urethane acrylates, epoxy acrylates, polyester acrylates, polyether acrylates, and melamine acrylates, and polymeric oligomers and monomers having a polymeric vinyl group such as acrylic acids, acryl amides, acrylonitriles, and styrenes, can be mentioned; furthermore, additives such as sensitizing agents can be added, as needed.

For the above-mentioned ionizing radiation curing resin, it is desirable when a monomer or prepolymer having a polyfunctional group is used for improvement in the general mechanical properties, such as surface strength and hardness, those with at least a bifunctional group can be

used effectively.

Furthermore, dispersing agents can be included in the above-mentioned ionizing radiation curing resin. When a dispersing agent is used, coating properties can be improved and polymer shrinkage can be prevented; furthermore, diffusion properties can be imparted. For the dispersing agent, glass, silica, alumina, insoluble plastics, talc, etc. can be used.

With regard to the ionizing radiation curing resins, properties required for the first ionizing radiation curing resin include good die reproduction characteristics, defoaming characteristics, ability to wet the die, and surface curability can be mentioned, and as properties required for the second ionizing radiation curing resin, good adhesion with the base material and good flow properties can be mentioned.

Furthermore, a resin with a viscosity adjusted to 200 centipoise or less is used for the first ionizing radiation curing resin, and a resin with a relatively high viscosity adjusted to 500~5000 centipoise is used for the second ionizing radiation curing resin. It is necessary for the first ionizing radiation curing resin to have a low viscosity since the resin is coated over the entire surface without trapping air bubbles in the spaces of the fine lens pattern of the molding tool, and it is necessary for the second ionizing radiation curing resin to have a high viscosity since purging of air bubbles on the resin is performed. When the first ionizing radiation curing resin is formed as described above, defoaming at the boundary of the molding tool can be improved further.

When two layers of resin are used as described above, the function of each resin with regard to the base, the lens sheet, and the molded lens sheet can be effectively achieved; furthermore, when functions of the resin are divided among the two layers, the resins can be

selected from among a wide variety of resins.

The conditions for selection of each second ionizing radiation curing resin are explained further below. In the case of a lens sheet, it is necessary for at least the refractive index of the two resins to be about the same. The reason for this is that the boundary between the first ionizing radiation curing resin and the second ionizing radiation curing resin laminated on it is not necessarily flat; thus, when the refractive index of the two resins is significantly different, a uniform beam cannot be achieved.

[p. 4]

As long as the above-mentioned relationship is satisfied, the same or different materials can be used for the above-mentioned first ionizing radiation curing resin and the second ionizing radiation curing resin. When different resins are used, resins having similar refractive indexes are used taking the properties of each resin into consideration, and for example, a urethane acrylate resin having good die reproducibility and surface curability can be used as the first ionizing radiation curing resin, and an epoxy acrylate resin having good adhesion with the substrate can be used for the second ionizing radiation curing resin. Furthermore, an adjustment can be made for properties such as wetting of the die, flow properties, and viscosity using methods such as changing the resin temperature during the course of the resin processing of the first ionizing radiation curing resin and second ionizing radiation curing resin, including additives (defoaming agents, leveling agents, etc.), and changing the mixing ratio of the monomers or oligomers of the first ionizing radiation curing resin and second ionizing radiation curing resin. When an adjustment is made with a solvent, it is desirable when the solvent used is evaporated after coating to prevent shrinkage of the resin or deterioration of the solvent.

Furthermore, a dispersing agent may be included in one or both of the above-mentioned first ionizing radiation curing resin and second ionizing radiation curing resin.

For the base material, a sheet or film having good solvent resistance, high transparency, and high ionizing radiation transmissivity can be used effectively. Furthermore, it is desirable when a resin having adequate adhesion with the ionizing radiation curing resin and high mechanical strength is used. For the above-mentioned base material, a primer layer having good adhesion with the base material, made of a substance such as a vinyl chloride/vinyl acetate copolymer and urethane can be deposited.

In the following, the lens sheet production method of the present invention is explained in further detail with the resin coating process as the focus.

Fig. 2~Fig. 4 are diagrams used for explaining the resin coating process of the lens sheet production method of the present invention.

In the present invention, the coating direction of the first ionizing radiation curing resin 2 on molding tool 1 applied in the first resin coating process step 101 is such that it forms a right angle with the application direction of the second ionizing radiation curing resin 5 applied in the lamination process step 103. In specific terms, the case where coating of the first ionizing radiation curing resin 2 is done by means of a squeegee coating method in production of a circular Fresnel lens sheet is used as an example. In this case, arrow I shows the coating direction for the first ionizing radiation curing resin in each of the figures, and arrow II shows the application direction of the second ionizing radiation curing resin (hereinafter referred to as nip compression direction) in each figure.

When the first ionizing radiation curing resin 2 is coated onto molding tool 1, squeegee 3 is moved in the direction indicated by arrow I (Fig. 2(b)). In this case, the squeegeeing is done against the peaks of molding tool 1 in the region between the left end of molding tool 1 and a point near the center, as shown in Fig. 2(c). Therefore, the resistance to the squeegee is high in the above-mentioned area and it is possible to generate foam 4 on the trailing sloped surfaces 1a of the peaks. The above-mentioned air bubbles 4 are more likely to form at the outer periphery of molding tool 1 where the depth of the grooves is higher and the resistance is highest at the time of squeegeeing (Fig. 2(d)).

Subsequently, second ionizing radiation curing resin 5 is applied by means of a dispenser, not shown in the figure, as shown in Fig. 3(a), and uniformly spread in the direction indicated by arrow Π_2 , which is the same coating direction as the first ionizing radiation curing resin 2, a portion of the air bubbles is left behind in the grooves in some cases. The reason is that when the pressure roll is moved in the direction shown by arrow Π_2 , the flow of the first ionizing radiation curing resin 2 is banked in the vertical regions 1b of the peaks of molding tool 1; thus, air bubbles are less likely to be purged.

For the reason explained above, in an effort to achieve a complete deaeration, the coating direction of the first ionizing radiation curing resin 2 in the present invention is at a right angle to application direction Π . In other words, as shown in Fig. 4, the first ionizing radiation curing resin is coated in a direction that is at a right angle to direction Π (the direction is indicated by arrow I) where nip compression is applied, and nip compression is applied in the direction shown by arrow Π_2 so that the first ionizing radiation curing resin flows in the tangential direction in concentric circles as shown by arrows III.

When the first ionizing radiation curing resin flows in the direction shown by arrows III, shifting of air bubbles in the direction shown by arrows III takes place and deaeration can be easily achieved.

Deaeration using the above-mentioned method is not limited to circular Fresnel lenses and the method can be applied effectively to production of linear Fresnel lenses, vertical prismatic lens sheets, lenticular lenses where many lens members are arranged in parallel. In this case, deaeration can be easily achieved when nip compression is performed in the longitudinal direction of the lens unit. The present invention can be applied to a lens sheet having a lens member on one surface of the base material as well as to a lens sheet having the same or different lens members on both surfaces. For example, double-sided lens sheets having a circular lens on one surface and a vertical prism or lenticular lens on the other surface, and double-sided lens sheets having a linear Fresnel lens having different lens units in the longitudinal direction, or lenticular lenses on both surfaces can be mentioned.

Furthermore, when a high proportion of the first ionizing radiation curing resin is applied to the region where the second ionizing radiation curing resin is to be applied, migration of air bubbles can be controlled (Japanese Patent Application No. Sho 63-115194 [1988]). In other words, when the first ionizing radiation curing resin is coated to form a thickness less than the height of the peak of the molding tool, and when the second ionizing radiation curing resin is applied under said condition, migration of air bubbles is likely to occur in the space between the first ionizing radiation curing resin and second ionizing radiation curing resin; thus, in order to prevent the above-mentioned problem, a high proportion of the resin is coated (coated to form a

height greater than the peak) and migration of air bubbles is prevented.

Furthermore, upon application of the second ionizing radiation curing resin, when a u-shaped pool of the second ionizing radiation curing resin is formed in lack of resin at the periphery of a molding tool having deep grooves can be prevented (Japanese Patent Application No. Sho 63-20927 [1988]), and when the second ionizing radiation curing resin is subsequently uniformly spread, complete dispelling of the air bubbles can be achieved.

The lens sheet production method based on the present invention can be used effectively for production of Fresnel lens sheets, prismatic lens sheets, lenticular lens sheets, etc., and the invention can be effectively used for moldings having a fine pattern on the surface such as optical cards, optical disks, and holograms.

[Application Examples]

In the following, the present invention is explained in further detail with application examples.

Fig. 5~Fig. 8 are drawings that show an application example of lens sheet production based on the present invention.

In this case, the same call-out numbers are used for the same functional members.

First, as first ionizing radiation curing resin 2, a urethane acrylate based resin having a refractive index of 1.49 and a viscosity adjusted to 100 centipoise was coated over the entire surface of molding tool 1 having a Fresnel lens pattern with a length and width of 1 m each and a pitch of 0.1 mm using a PET (polyester) doctor blade with a thickness of 0.5 mm in the direction shown by arrow I in Fig. 5.

Subsequently, a resin pool of second ionizing radiation curing resin 5 of 0.5 g/cm^2 was

formed on the above-mentioned first ionizing radiation curing resin 2 using the flow coating method, as shown in Fig. 6. For the above-mentioned second ionizing radiation curing resin 5, an epoxy-acrylate based resin having a refractive index of 1.49 and a viscosity adjusted to 1500 centipoise was used.

After forming the resin pool, a transparent acrylic sheet without an ultraviolet absorber and having a thickness of 3.0 mm and coated with a vinyl chloride/vinyl acetate copolymer based primer was laminated as base 6, and pressure rolls 7,7 were applied at a rate of 50 cm/min in the direction shown by arrow II in Fig. 7. In this case, air bubbles between molding tool 1 and base 6 were purged in the area indicated by 2a in the figure. Subsequently, 160 W/cm ultraviolet (UV) is applied from the base material side by means of an ultraviolet light source 8, and curing of the first ionizing radiation curing resin and second ionizing radiation curing resin is achieved.

And finally, release from the molding tool is carried out as shown in Fig. 8 and production of a Fresnel lens sheet is achieved. In the above-mentioned Fresnel lens sheet, the lens member portion comprises the first ionizing radiation curing resin and the base material side of the lens member comprises the second ionizing radiation curing resin, to which base material 6 is further laminated. In this case, air bubbles was absent in the above-mentioned Fresnel lens sheet.

[p. 6]

[Effect of the invention]

As explained in detail, according to the method of the present invention, removal of the air bubbles is facilitated since coating of the first ionizing radiation curing resin onto the molding tool is done at a right angle to the direction of application of the second ionizing radiation curing

resin, and production of a lens sheet without air bubbles without an increase in production cost is made possible.

4. Brief description of the figures

Fig. 1 is a diagram used for explanation of the lens sheet production method of the present invention.

Fig. 2~Fig. 4 are drawings used for explaining the resin coating process used in the lens sheet production method of the present invention.

Fig. 5~Fig. 8 are drawings that show an application example of the production of a lens sheet by the production method of the present invention.

1: Molding tool

2: First ionizing radiation curing resin

3: Squeegee

4: Air bubbles

5: Second ionizing radiation curing resin

6: Base material

7: Pressure roll

8: Ultraviolet light source

I: Coating direction of the first ionizing radiation curing resin

II: Application direction of the second ionizing radiation curing resin

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Fig. 1

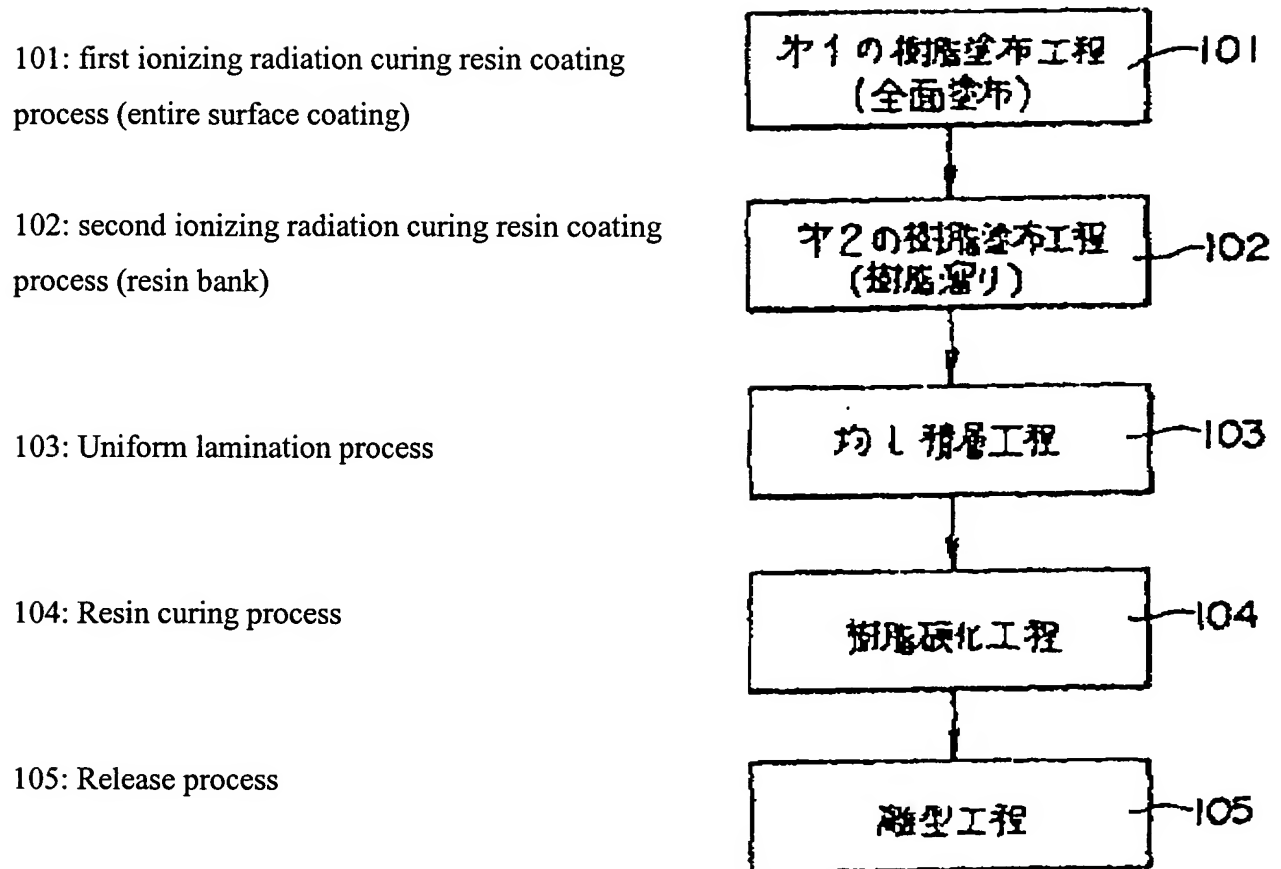


Fig. 2

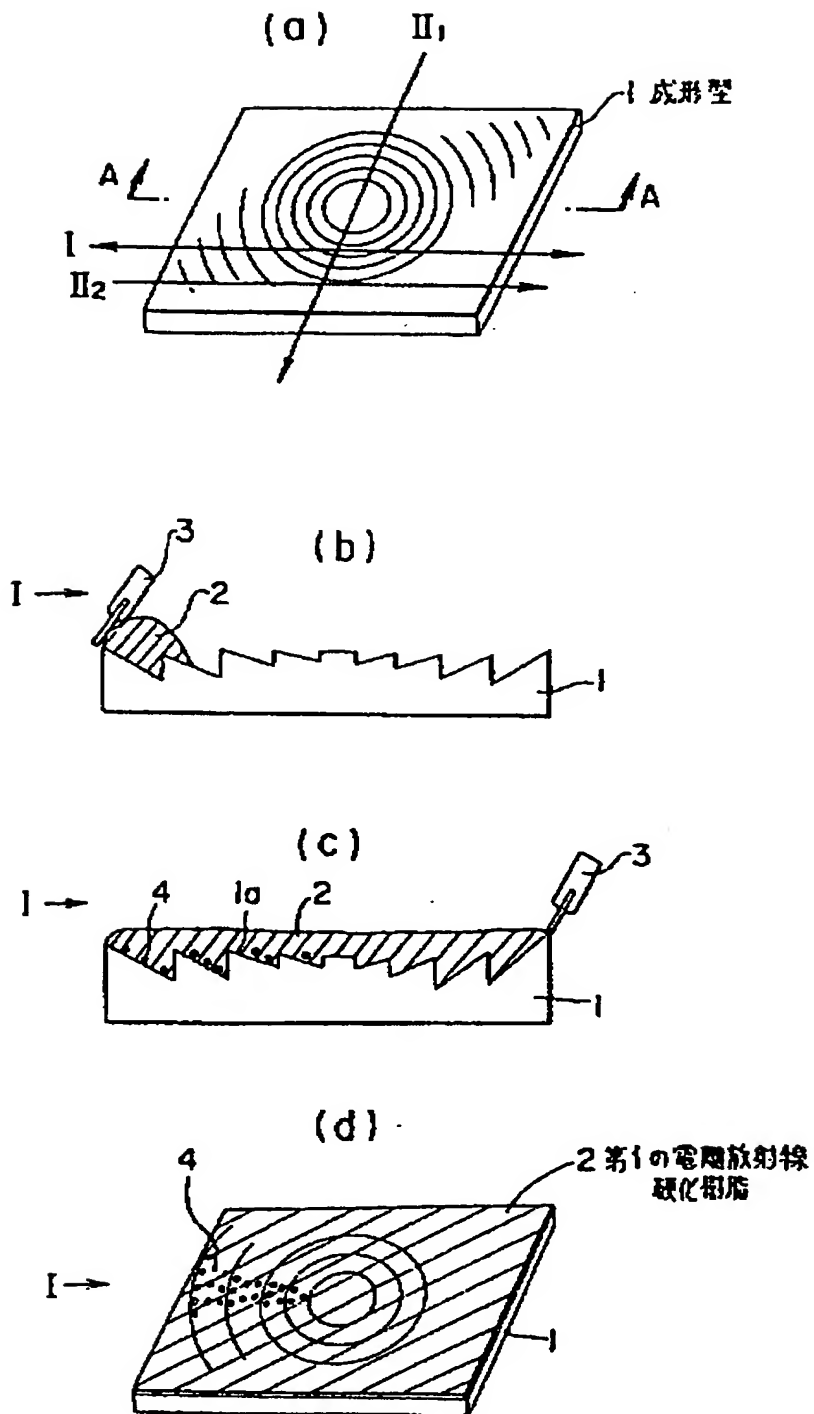


Fig. 3

5: Second ionizing radiation
curing resin

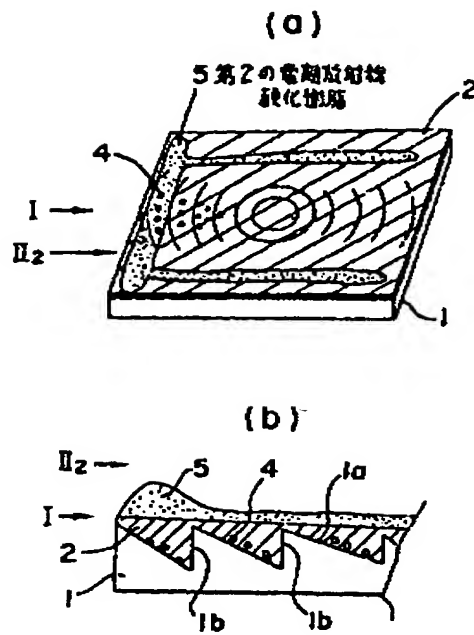


Fig. 4

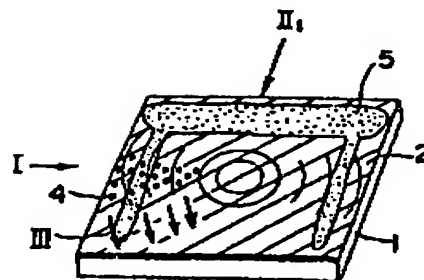


Fig. 5

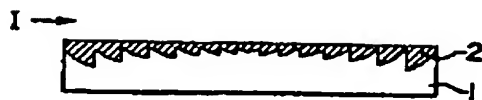


Fig. 6

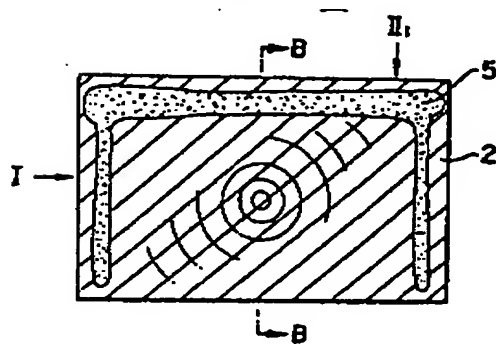


Fig. 7

8: UV light source

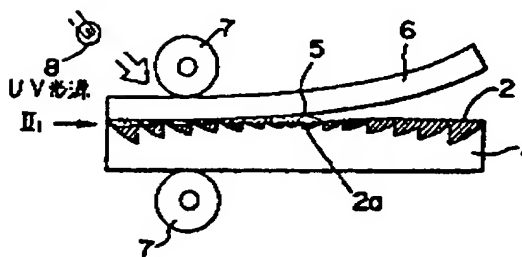


Fig. 8

